REPORT NO. NADC-83041-60

12

FUEL FIRE TESTING OF THE QUICK-DONNING ANTI-EXPOSURE SUIT CWU-60/P QUICK-DONNING, ANTI-EXPOSURE COVERALL

AD A140152

George H. Kydd & Gregory K. Askew
Aircraft and Crew Systems Technology Directorate
NAVAL AIR DEVELOPMENT CENTER
Warminster, Pennsylvania 18974

FEBRUARY 1983

FINAL REPORT
AIRTASK NO. A531531A/001D/4W0606SL00
P.E. 64264N

Approved for Public Release: Distribution Unlimited

Prepared For
NAVAL AIR SYSTEMS COMMAND
Department of the Navy
Washington, DC 20361

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1. REPORT NUMBER: NADC-83041-60	2. GOVT ACCESSION NO.: AD-A140152
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Fuel Fire Testing of the Quick-Donning Anti-Exposure Suit (CWU-60/P Quick-Donning, Anti-Exposure Coverall)	5. TYPE OF REPORT & PERIOD COVERED: Final Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): George H. Kydd Gregory E. Askew	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Air Development Center Aircraft & Crew Systems Technology Directorate Warminster, PA 18974	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AIRTASK NO. A531531A/001D/4W0606SL00 P.E. 64264N
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Air Systems Command Department of the Navy Washington, DC 20361	12. REPORT DATE: February 1983
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Q-D, Quick-Donning, Anti-Exposure

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Three specimens of Quick-Donning Anti-Exposure Suits were tested at the Fuel Fire Test Facility in three second exposures using JP-4 jet engine fuel. One was a commercial suit designated, Imperial, a chemically expanded neoprene with nylon laminates on the inner and outer surfaces; one was a nitrogen blown neoprene with a sharkskin on the outer surface; and the third was also nitrogen expanded neoprene, the outer face having a Nomex laminate. The Imperial Suit supported combustion very well and had to be extinguished. The sharkskin self extinguished except for two suits that tended to flame, one at the crotch and one under the arm. The Nomex Clad Neoprene was little affected by the fire.

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APPENDIX A

MOVIE COVERAGE – QUICK DONNING SUITS

QDCG2203066	Burning intensely at the back. Fire begins to envelope non-burning areas (front) and had to be extinguished.
QDCG2207069	Blazing intensely at the back; with some scattered flames in the front. Again it had to be extinguished.
QDCG2207072	Burning only at the feet. Not a good fire.
QDSG2203067	Only smoke from the rear.
QDSG2207070	Burning from the rear, but it extinguished itself by the time it came to rest.
QDSG2211073	Some flaming; self-extinguishing (S.E.)
QDBR2204068	Burning intensely at the back. The fire S.E. except at the crotch where it had to be extinguished.
QDBR2207071	Burning intensely (with black smoke obscuring the view). Fire was put out.
QDBR2211075	Extensive burning with persistence under right arm and crotch, not threatening. Other areas S.E.

INTRODUCTION

The requirement for survival in cold water was recently demonstrated by an incident in the North Pacific when a crew onboard an anti-submarine aircraft (VP) was forced to ditch. Survival in such circumstances is dependent upon the maintenance of body temperature and preventing heat losses to the surroundings. Missions over cold water are not uncommon in the VP community and the principal means of survival for crewmen who have to ditch is the Quick-Donning Anti-Exposure Suit (QD). The suit is constructed of 3/16 in. gas-blown neoprene and it is constructed to fit over the other clothing a crewman may be wearing. As the name implies, it is designed to be put on rapidly, as it may have to be in an emergency. Since ditching could occur in conditions of fire onboard, or in the water, it is required that the QD be resistant to flames. The first series of tests consisted of three specimens of each of three types that were exposed for three seconds.

METHOD

The assemblies were tested at the NADC Fuel Fire Test Facility which employes a rotary crane to carry the dressed manikin over the fire pit, through the flames. The fuel was JP-4 and the rotation of the crane was adjusted so that the manikin was over the pit for three seconds. The fire pit is a concrete rectangle constructed to contain water to about eight inches. The surface is divided by a grid of aluminum angle that contains 12 cells, each of which has a fuel nozzle at the floor of the fire pit. Fuel is pumped through the nozzles and is allowed to float to the top of the water and spread within the cell. In this way an even distribution of fuel is obtained. At the proper time the fuel is ignited by four air-propane igniters located around the perimeter of the pit; the fire is allowed to develop and the crane is started.

The fire pit is enclosed on three sides by a high steel fence which sets back about 15 feet on each side. The cameras, mentioned below are placed to view through ports cut through the fence. The fourth side of the pit is shielded by a concrete block wall, behind which operations are controlled. The TV cameraman is also behind this wall so that he can view the manikin as it rounds the wall from the pit. In these tests photography was enhanced by use of a longer focal length lens (50 mm) on one movie camera, making it possible to view the manikin close-up as it came over the edge of the fire pit. A second movie camera was equipped with a 10 mm lens. The intensity of the fire was obtained from a calorimeter that was positioned alongside the left thigh of the manikin looking forward. The manikins were dressed in winter flying outfits that included Nomex long underwear, a flight suit, winter trousers and jacket. Three varieties of quick-don exposure suits were tested: the Imperial Suit which is chemically expanded neoprene with nylon laminates on the inner and outer surfaces; a nitrogen blown neoprene with sharkskin texture on the outer surface and a nylon laminate on the inner surface; and the third which was also of nitrogen blown neoprene but which had an outer face of Nomex laminate and an inner face of nylon laminate.

RESULTS

The results of the movie footage are given for each specimen in Appendix A and are summarized below:

Imperial Suits. Two of the three were burning fiercely at the back as they emerged. The fire grew in intensity and threatened to involve the front and had to be extinguished. The third specimen experienced a less intense fire in the pit and, therefore, did not burn.

Nomex-Clad Suits. These three suits survived well although two showed some flaming at the end of the run in both instances. The flames self-extinguished in a few seconds after exiting the pit flames.

Sharkskin Suits. These gas expanded neoprene suits were characterized by some flaming. One specimen burned at the crotch and had to be put out; while another burned under the right arm and was put out. Otherwise, they tended to self-extinguish.

Front, back and side views of the manikin are shown for each of the suits before and after the exposure requiring six photographs for each.

Nomex-Clad Suit. Figures 1-6. There was little change. One suit had brownish streaks in front, but they were mainly unaffected.

Imperial Suit. Figures 7-12. There was a progression of color changes from red, to brown, to buff, to charring (black). The backs showed most discoloration with the two suits that burned most: The front was just beginning to be discolored but was still orange, or in the other case, it was burned to buff but with most areas still orange.

Sharkskin Suit. Figures 13-18. Burned areas in these suits showed areas of small irregular cracks with the release of the carbonaceous material that would rub off on the hands.

None of the manikin surface sensors were activated. The minimum temperature 120°F.

DISCUSSION

Although the samples were small, one got the impression from the tests of the Imperial Suit that the material will support combustion such that even a small fire could develop into an engulfing one (At this point, results from a vertical flame test that would test this hypothesis are not available). Because of this characteristic one should be extremely cautious in not exposing the material to increases in temperature certainly when it is worn but also in storage.

In comparison, the Sharkskin while burning somewhat, did not present the threat of a spreading fire that the Imperial Suit did. The two areas that burned on two suits separately were the crotch and the armpit which may be expected to have limited radiation of heat and thus, may get hotter. These areas also contain seams and junctures and there is the possibility that the adhesive material may be flammable in these circumstances. This particular burning also presents the possibility of separate treatment such as being covered with a non-flammable covering material.

The Q.D. and Fire Exposure. The scenario on which the fuel fire test is based is one in which a crewman has to escape from burning fuel on a carrier deck. The duration of the test is therefore based on the amount of time required to move from the site of the fire to a safe place and traditionally this has been three seconds, the time used in the present tests. It would appear that the Q.D. may not fit the basic scenario for the following reasons:

1. The coverall would never be worn on the deck of a carrier, therefore, escaping from burning fuel on the carrier deck would not be a contingency.

2. The Q.D. Coverall is worn in a ditching operation and an extensive fire such as that used here, on a ditched aircraft, is a remote possibility.

The more likely situation would be a wet coverall exposed to burning material including fuel on a water surface which would expose the coverall and its wearer to much less heat than that used in the present tests. This being the case, the Q.D. Coverall passes this test and is considered safe for use in the fleet.

Conclusion:

The Sharkskin and the Nomex Clad Q.D. Coverall are considered sufficiently flame resistant to be used in the Fleet. The Imperial Coverall, as indicated by these tests, would be a fire hazard for the crewman in an emergency situation and care should be taken in ordinary handling and storage in the vicinity of open fires.

Figure 1. Nomex Clad Sharkskin, Front, before

Figure 2. Nomex Clad Sharkskin, Front, after

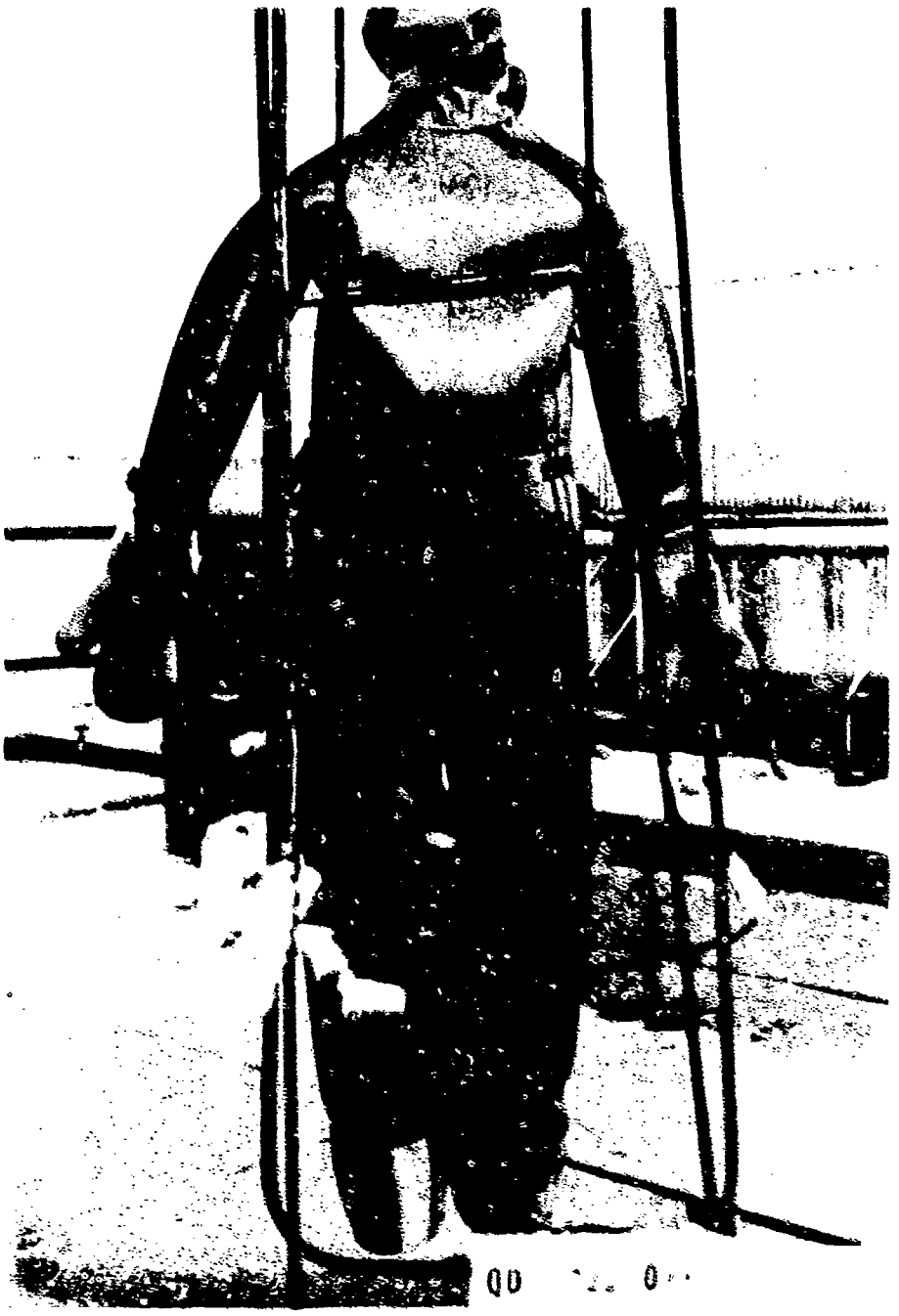

Figure 3. Nomex Clad Sharkskin, Back, before

Figure 4. Nomex Clad Sharkskin, Back, after

Figure 5. Nomex Clad Sharkskin, Side, before

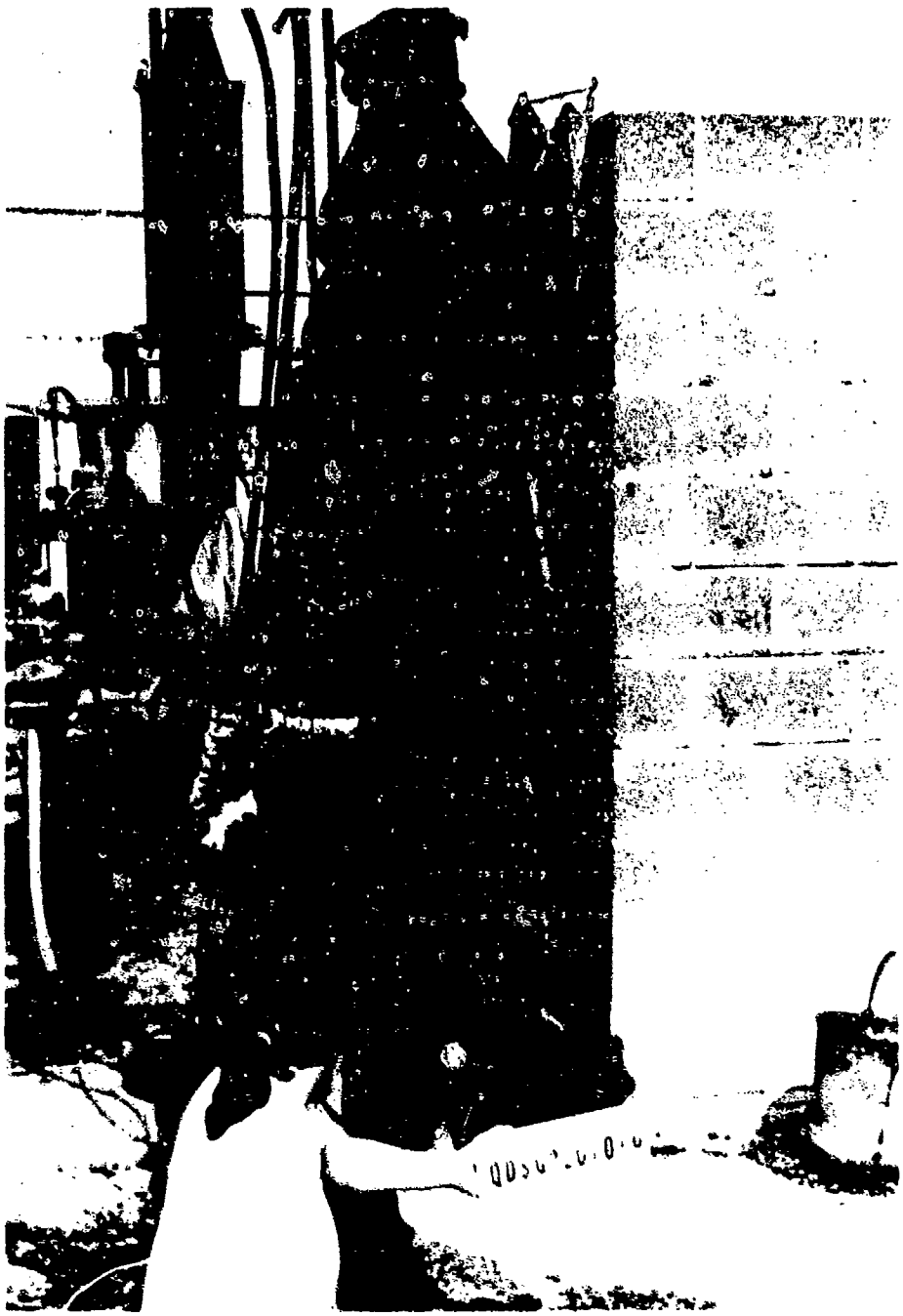

Figure 6. Nomex Clad Sharkskin, Side, after

Figure 7. Imperial Suit, Front, before

Figure 8. Imperial Suit, Front, after

Figure 9. Imperial Suit, Back, before

Figure 10. Imperial Suit, Back, after

Figure 11. Imperial Suit, Side, before

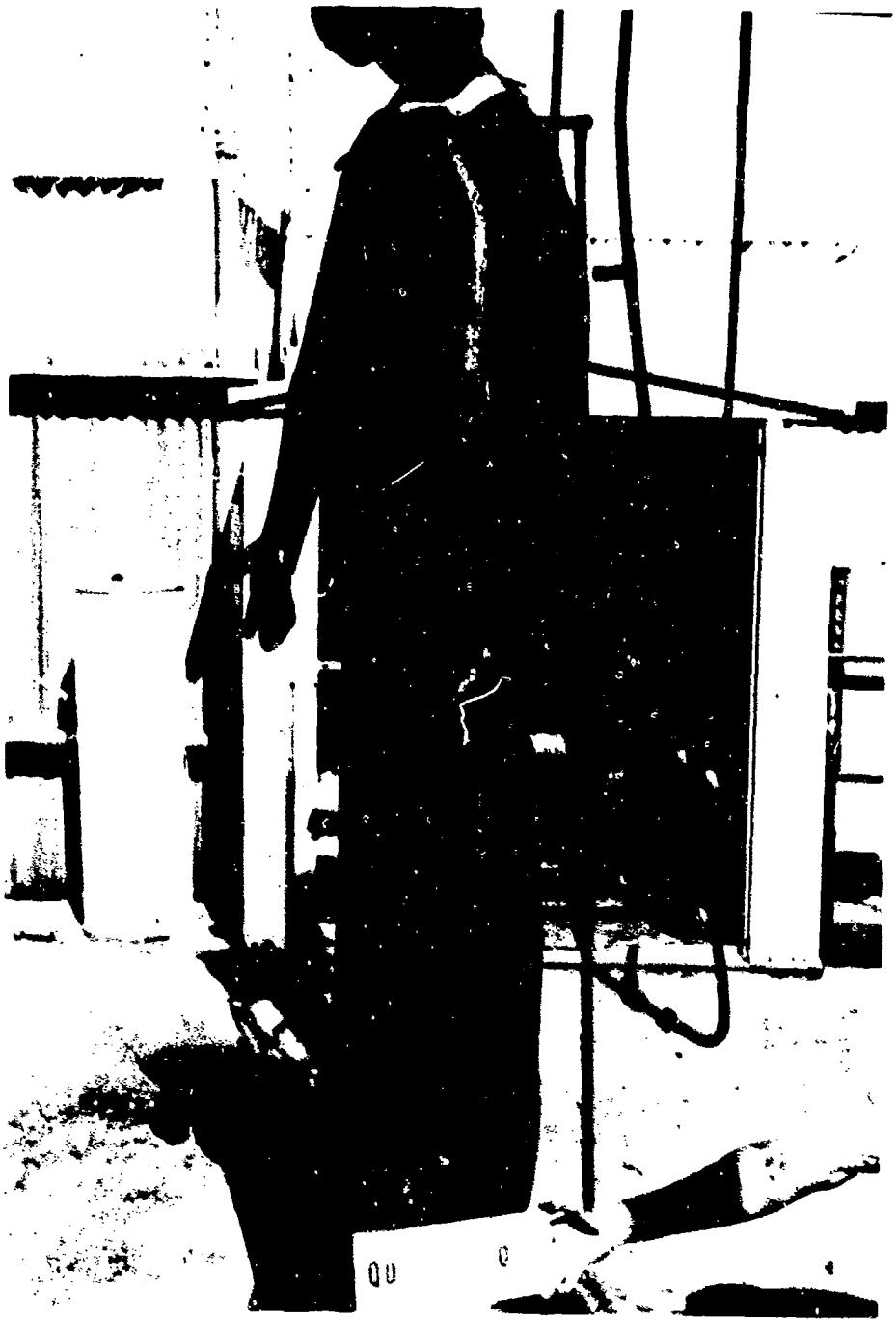

Figure 12. Imperial Suit, Side, after

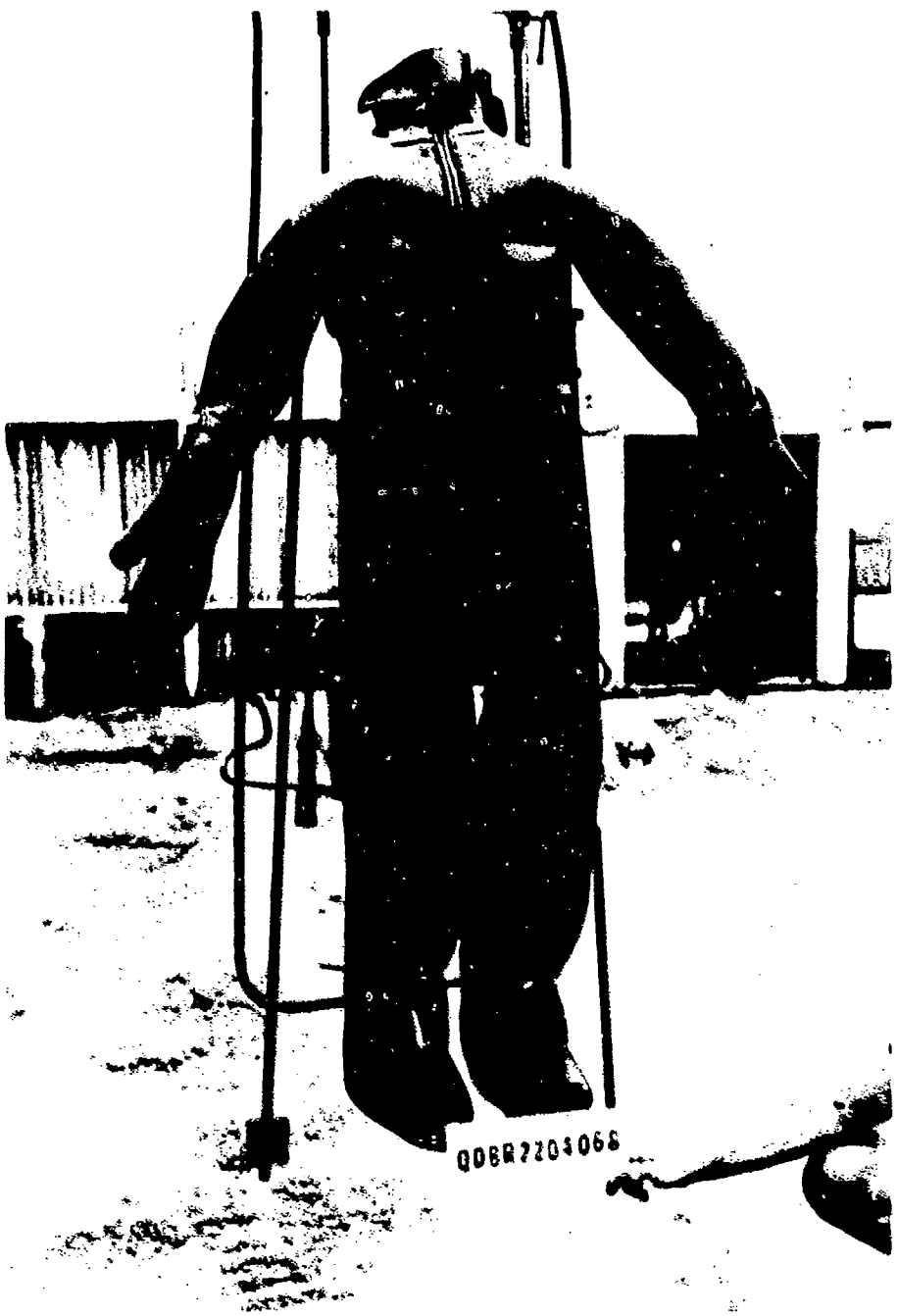

Figure 13. Sharkskin, Front, before

Figure 14. Sharkskin, Front, after

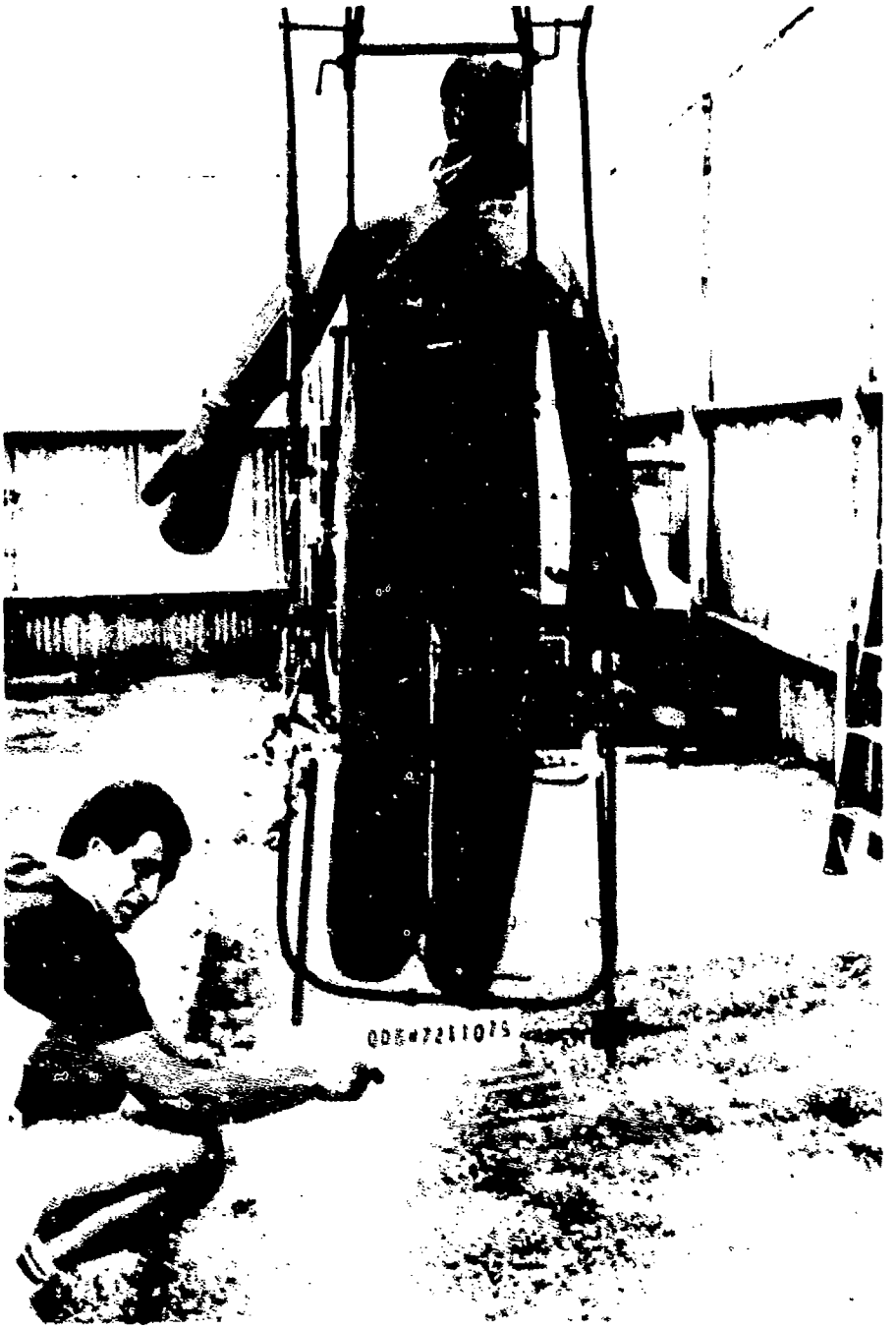

Figure 15. Sharkskin, Back, before

Figure 16. Sharkskin, Back, after

Figure 17. Sharkshin, Side, before

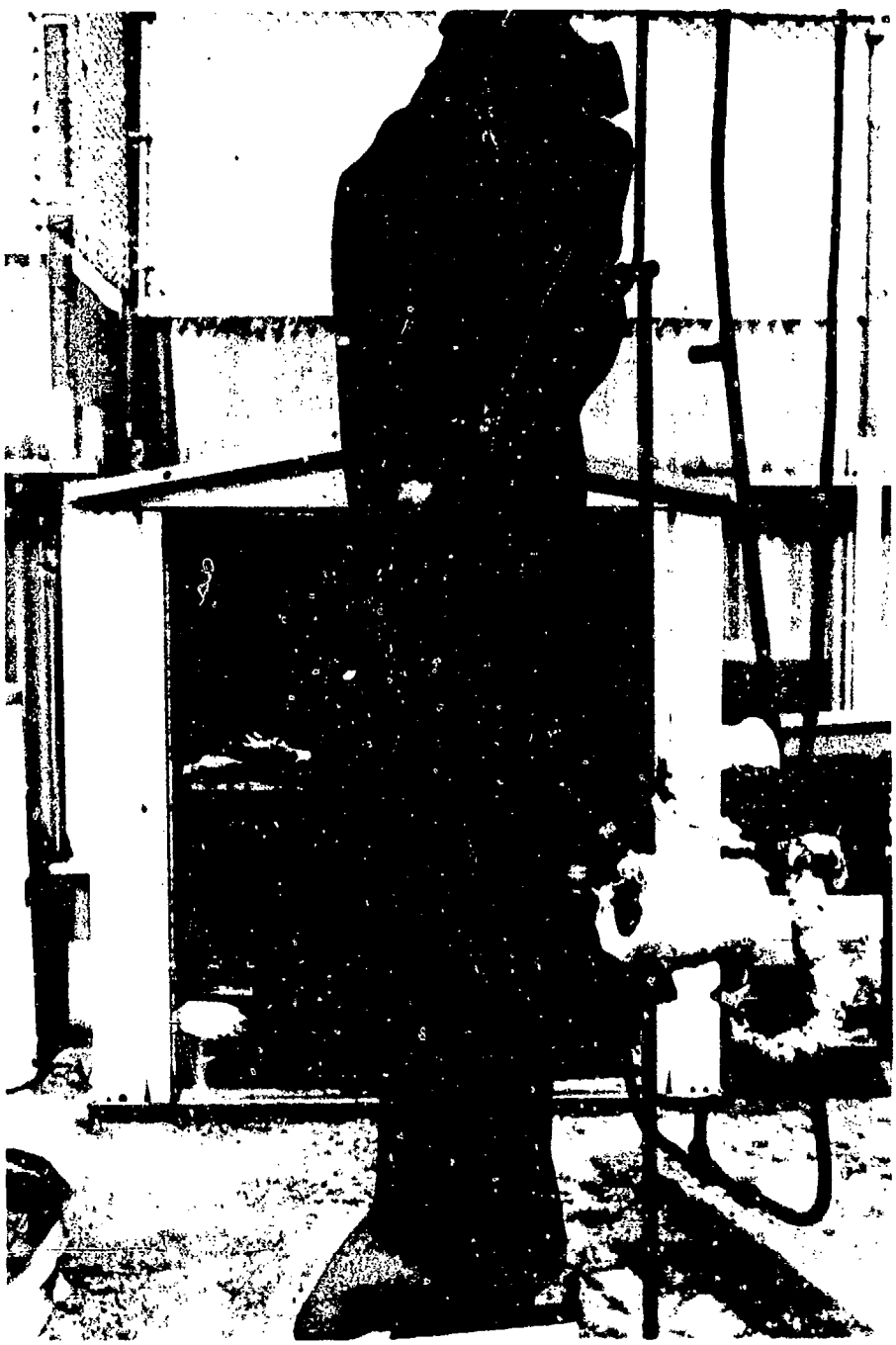

Figure 18. Sharkskin, Side, after

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